PORTER (Wm J.)

THE RELATION BETWEEN THE GROWTH OF CHILDREN AND THEIR DEVIATION FROM THE PHYSICAL TYPE OF THEIR SEX AND AGE.

presented by the author

WM. TOWNSEND PORTER.
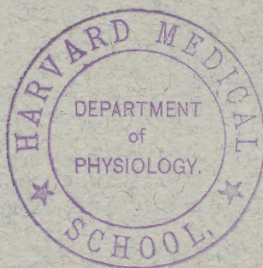
THE RELATION BETWEEN THE GROWTH OF CHILDREN AND THEIR DEVIATION FROM THE PHYSICAL TYPE OF THEIR SEX AND AGE.

WM. TOWNSEND PORTER.

Quetelet induced from his measurements of children the law that the weights, heights or other physical dimensions at each age in the period of growth are approximations of a median value,[1] about which they are grouped in the form of a probability curve, being related to the median value as the individual observations in a series of measurements of the same thing are related to its actual size. Quetelet assumed that the median value of an anthropometric series expressed the physiological type of the series and that each deviation from this value expressed the physiological difference between an individual and the type. Fifty years of research have placed the truth of Quetelet's law beyond all doubt and have not weakened the reasonableness of his assumption, so that both law and hypothesis are rarely questioned and are regarded as a secure base from which to explore the phenomena of growth.

The degree of deviation of the individual measurements from the median value of an anthropometric series is measured by the Probable Deviation, that value which, in the words of Lexis,[2] is as often exceeded as attained. Hence, if Quetelet's theory is true, the Probable Deviation is a measure of the degree of deviation of individuals from their Physical Type. The Probable Deviation from the median value of a

---

[1] *Moyenne* of Quetelet, see *Lettres sur la Théorie des Probabilités*, Bruxelles, 1846, page 66; and *mean* of Sir John Herschel and other English writers, see *Edinburg Review*, 1850, page 23.

[2] Ueber die Theorie der Stabilität statistischer Reihen. Hildebrand's Jahrbücher für Nationalökonomie und Statistik. Bd. 32, 1879, S. 60–98. See page 62.

234 Trans. Acad. Sci. of St. Louis.

series containing many measurements may be calculated by
the approximation formula

$$d = \pm 0.8453 \frac{\Sigma\delta}{n} \qquad (1)$$

where d = Probable Deviation,
    δ = Deviation of individual from median value,
    $\Sigma\delta$ = Sum of individual deviations,
    n = Total number of observations.

The Probable Deviation contains the Error of Observation,
as well as the Physiological Difference of the Individual from
the Type. The Error of Observation, in a large series of
measurements, is always relatively small. Its insignificance
can be made clear in several ways. If the height of one boy
at any age is measured 1000 times, the Probable Deviation
will be much smaller than when the heights of 1000 boys at
that age are measured once. Compare, for example, the
Probable Deviation from the average height of one boy aged
17 measured 78 times with that of 78 boys aged 17 measured
once, the measurements being made under conditions as nearly
alike as possible in both instances.

One Boy aged 17 Measured 78 times.	78 Boys aged 17 Measured once.
Average Height 176.28 cm.	165.13 cm.
Probable Deviation $\pm$ 0.24 cm.	$\pm$ 5.15 "

In the single boy, the Difference of the Individual from the
Type is not present and the Probable Deviation is very small:
in the 78 boys, the opposite is true. Yet the difficulty of cor-
rect measurement and hence the Error of Observation in each
measurement in the two series cannot differ greatly. It fol-
lows that by far the greater portion of Probable Deviation is
made up of the Physiological Difference of Individual from
Type.

Again, the Error of Observation is inversely as the square
root of the number of observations and should, were it an
important constituent of the Probable Deviation, cause the
latter to increase as the number of observations decreased.

Thus, in the following table, comparing the Relative Probable Deviation from the average height standing of boys with the square roots of the number of observations, the Probable Deviation should be much greater at ages 17 and 18, in which the number of observations is small, than at age 10 or 11, in in which the observations are much more numerous. A look at the figures shows that the Probable Deviation is very little

Age at nearest Birthday.	Number of Observations.	Square Root.	Relation of Probable Deviation to Average.
6	709	26.63	3.1 %
7	1850	43.01	3.2
8	2223	47.15	3.3
9	2205	46.95	3.0
10	2087	45.68	3.1
11	1819	42.63	3.2
12	1653	40.67	3.2
13	1268	35.62	3.5
14	925	30.42	3.8
15	490	22.14	4.1
16	189	13.75	3.7
17	78	8.85	3.1
18	29	5.40	2.8

influenced by variations in the number of observations, within the limits given here. The Probable Deviation may, therefore, without any error of importance, be considered as the Physiological Difference between the Individual and the Type.

Not all observers have taken the Median Value as the Type. The arithmetic mean is frequently employed in Germany, Denmark and elsewhere. In a large series the difference between the two is so small that either may be safely used. The maximum and the mean Median minus Average values for the physical dimensions studied in this paper are as follows:—

MEDIAN MINUS AVERAGE VALUE.

DIMENSION.	UNIT OF MEASUREMENT.	MAXIMUM.		ARITHMETIC MEAN.	
		BOYS.	GIRLS.	BOYS.	GIRLS.
Weight............	Kilogram..........	0.73	0.74	0.23	0.25
Height Standing...	Centimetre	1.00	1.10	0.50	0.49
Height Sitting.....	Centimetre	0.94	0.99	0.44	0.67
Span of Arms......	Centimetre	1.35	1.33	0.53	0.59
Girth of Chest.....	Centimetre	0.84	0.71	0.44	0.46

There can, therefore, be no objection to the use of the

Average in place of Median Value in the series about to be studied.

The accuracy of the average can be estimated by the formula:[1]

$$E = \pm \frac{d}{\sqrt{n}} \qquad (2)$$

where E = Probable Error of Average,
d = Probable Deviation from Average,
n = Number of Observations.

The values for E are given in Tables No. 6, 7 and 8.

It has already been said that the Physiological Difference between the Individual and the Type is expressed by the Probable Deviation from the Average. According to Geissler and Uhlitzsch,[2] the interval between Average minus d and Average plus d increases with the age. The values of d found by them in their measurements of height standing are as follows (page 33):

AGE.	PROBABLE DEVIATION ($A \pm d$).	
	Boys. $\pm$	Girls. $\pm$
6½ to 7 years	3.4488	3.5926
7 " 8 "	3.5841	3.7362
8 " 9 "	3.8546	3.8293
9 " 10 "	4.0067	3.7785
10 " 11 "	4.2181	4.2265
11 " 12 "	4.2434	4.4125
12 " 13 "	4.5984	4.8013
13 " 14 "	4.7844	5.2155
Over 14 "	5.1479	4.8520

The authors say concerning this table (page 34) : —

" Hieraus geht hervor, dass diese Intervalle mit dem Alter
" im Allgemeinen zunehmen und es dürfte dies auch ganz
" natürlich erscheinen, da wohl anzunehmen ist, dass die das
" Wachsthum hemmenden bez. fördernden Ursachen bei den
" meisten Individuen ziemlich dieselben bleiben, den Unter-

---

[1] Formulas (1) and (2) are contained in L. Stieda's paper: Ueber die Anwendung der Wahrscheinlichkeitsrechnung in der anthropologischen Statistik. *Archiv für Anthropologie*, Bd. xiv, 1882, S. 167–182.

[2] Arthur Geissler and Richard Uhlitzsch. Die Grössenverhältnisse der Schulkinder im Schulinspectionsbezirk Freiberg. *Zeitschrift des königlichen Sächsischen Statistichen Bureaus*, xxxiv, Heft 1 and 2, 1888, S. 28–40.

" schied also in der Grösse der Individuen immer merklicher
" hervortreten lassen. Auch hinsichtlich der Geschlechter ist
" ein Unterschied deutlich bemerkbar und zwar zeigen sich
" für die Mädchen vom 11 Jahre an grössere Schwankungen
" als für die Knaben. Da aber beobachtet worden ist, dass
" die Mädchen circa zwei Jahre vor Eintritt der Pubertäts-
" periode verhältnissmässig rascher wachsen, so dürfte die
" Verschiedenheit, mit welcher der Eintritt dieser Zeit erfolgt,
" wohl ein Grund mit sein für die grösseren Schwankungen."

It appears from this extract from the valuable work of
Geissler and Uhlitzsch that they were very near discovering
the law which it is the purpose of this paper to demonstrate
and would certainly have done so had they not contented
themselves with the Absolute Probable Deviation, in which
the real Physiological Difference of Individual from Type
lies hidden, and had the material furnished them been
sufficiently extensive. The Absolute Probable Deviation is
entangled with the size of the individual, and its true value
can be known only when this disturbing factor is removed.
It is the relation between Probable Deviation and size of
individual that must be studied, if the character of the
Probable Deviation would be known. But even if Geissler
and Uhlitzsch had pursued the method just suggested, the
limitations of their material would have prevented them from
solving the problem completely. For the material given
them to analyze extended no further than the fourteenth year,
with some observations over, almost wholly missing the
period of pre-pubertal acceleration in boys and the early
pubertal years in girls and entirely omitting the early pubertal
years in boys.

It would seem from their results that the Probable Devia-
tion increases with the age, whereas it shall be presently shown
that the Absolute Probable Deviation in height standing as
well as in weight, height sitting, span of arms and girth
of chest does not increase with age during the whole period of
growth. Moreover, the Relative Probable Deviation does not
increase during seven of the nine years of boys' growth and
five of the nine of girls' growth included in the observations of
Geissler and Uhlitzsch, and shows a merely secondary relation

to age during the remaining years. They state further that the amount of the Probable Deviation from age 11 on is greater in girls than in boys, meaning of course that this is true within the limits of their own observations. A wider experience shows that the Absolute Probable Deviation in height standing of girls ceases to be greater than that of boys at age 14 (nearest birthday). Finally, it does not appear from the context that the statement " Da aber beobachtet worden ist, " dass die Mädchen circa zwei Jahren vor Eintritt der Puber- " tätsperiode verhältnissmässig rascher wachsen, so dürfte die " Verschiedenheit, mit welcher der Eintritt dieser Zeit erfolgt, " wohl ein Grund mit sein für die grösseren Schwankungen " includes the conception of the relation of the Probable Deviation to the quickness of growth (to be demonstrated below), as distinct from the absolute difference in size of boys and girls at this period.

Before applying to the present material the ideas which the foregoing paragraphs have attempted to state with some precision, it will be interesting to compare the Probable Deviation of Height Standing of German children in the Freiberg district with that of the St. Louis children.

TABLE No. 1.

A Comparison of the Absolute Probable Deviation from the Average Height Standing of School Children in the Freiberg School District (Geissler & Uhlitzsch) and in the St. Louis Public Schools.

St. Louis Age at Nearest Birthday.	BOYS.		GIRLS.		FREIBERG AGE.
	St. Louis.	Freiberg.	St. Louis.	Freiberg.	
	±	±	±	±	
6	3.40 cm.	3.4488 cm.	3.42 cm.	3.5926 cm.	6½ to 7 yrs.
7	3.61 "	3.5841 "	3.75 "	3.7362 "	7 – 8 "
8	3.89 "	3.8546 "	3.70 "	3.8293 "	8 – 9 "
9	3.75 "	4.0067 "	3.83 "	3.7785 "	9 – 10 "
10	3.98 "	4.2181 "	4 06 "	4.2265 "	10 – 11 "
11	4 23 "	4.2434 "	4.48 "	4.4125 "	11 – 12 "
12	4.47 "	4.5984 "	5.23 "	4.8013 "	12 – 13 "
13	4.98 "	4.7844 "	5.46 "	5.2155 "	13 – 14 "
14	5.58 "	5.1479 "	5.15 "	4.8520 "	over 14 "
15	6.33 "		4.01 "		
16	5.87 "		4.05 "		
17	5.15 "		3.45 "		
18	4.98 "		3.39 "		
19			4.04 "		
20			3.14 "		
21			4.27 "		

The agreement between the series is satisfactory and demonstrates the stability of the method as well as the accuracy with which it has been employed in these particular instances. The coincidence is the more significant because the St. Louis children are taller than the Freiberg children.

TABLE No. 2.

A Comparison of the Average Height Standing of School Children in the Freiberg School District (Geissler and Uhlitzsch) and in the St. Louis Public Schools.

St. Louis Age at Nearest Birthday.	Boys.		Girls.		Freiberg Age.
	St. Louis.	Freiberg.	St. Louis.	Freiberg.	
6	108.94 cm.	108.6 cm.	107.67 cm.	107.9 cm.	6½ to 7 yrs.
7	114.03 "	112.6 "	112.95 "	112.0 "	7 – 8 "
8	119.13 "	117.6 "	118.36 "	116.7 "	8 – 9 "
9	124.35 "	122.1 "	123.67 "	121.5 "	9 – 10 "
10	128.87 "	126.7 "	128.43 "	126.1 "	10 – 11 "
11	133.84 "	130.6 "	133.19 "	131.0 "	11 – 12 "
12	138.21 "	135.5 "	139.11 "	135.5 "	12 – 13 "
13	142.91 "	140.1 "	146.53 "	141.6 "	13 – 14 "
14	148.58 "	144.1 "	150.84 "	145.5 "	over 14
15	154.90 "		155.04 "		
16	160.27 "		157.52 "		
17	165.13 "		159.33 "		
18	170.41 "		159.42 "		
19			158.46 "		
20			159.41 "		
21			159.98 "		

It follows from table No. 1 that *The Physiological Difference between individual school children and the Physical Type of their sex and age is essentially the same, where the differences between the children compared are not greater than those existing between the St. Louis and the Freiberg children.*

The material now to be discussed is presented in Tables No. 6, 7 and 8 and consists of the Number of Observations, Average, Probable Error of Average, Probable Deviation, Relative Annual Increase of Average and Relation of Probable Deviation to Average of Weight in indoor clothing, Height standing without shoes, Height Sitting, *i. e.*, height from the crown of the head to the chair on which the child sits erect, Span of Arms, or distance between the tips of the middle fingers when the arms are extended in a plane with the shoulders, and Girth of Chest, obtained by adding the girth of the chest

on a level with the nipples at full inspiration to the girth at
full expiration and dividing by 2, the measurement being
made over the boys' shirts and the girls' dresses, the corsets
occasionally worn by American school girls being previously
removed.   The manner of making the measurements is fully
described in the author's work On the Growth of St. Louis
Children, about to be published by the Academy of Science of
St. Louis.

The Absolute Probable Deviation from the Average is
given in Table No. 3, extracted from Tables No. 6, 7
and 8.   The total deviation of the five dimensions meas-

TABLE No. 3.

THE ABSOLUTE PROBABLE DEVIATION FROM THE AVERAGE: $d = \pm\, 0.8453\,\dfrac{\Sigma\,\delta}{n}$

Age at nearest Birthday and Absolute Probable Deviation from Average.

Dimension	Sex	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±
Weight	Boys.	1.43	1.68	1.96	2.09	2.23	2.60	2.46	3.88	4.56	5.06	6.16	4.38				
	Girls.	1.44	1.88	1.95	2.23	2.31	2.91	3.31	4.22	4.67	4.05	4.24	3.70	3.60	3.76	3.76	
Height Standing.	Boys.	3.40	3.61	3.89	3.75	3.98	4.23	4.47	4.98	5.58	6.33	5.87	5.15	4.98	4.04	3.14	4.27
	Girls.	3.42	3.75	3.70	3.83	4.06	4.48	5.23	5.46	5.15	4.01	4.05	3.45	3.39			
Height Sitting.	Boys.	2.82	2.64	2.26	2.34	2.42	2.56	2.72	2.74	3.15	3.59	3.48	3.77	2.89	1.82	2.03	1.86
	Girls.	2.03	2.19	2.04	2.11	2.19	2.37	2.61	2.87	3.11	2.54	2.36	2.17	1.72			
Span of Arms.	Boys.	3.85	4.16	4.18	4.25	4.70	4.84	4.57	5.71	6.03	7.15	7.89	5.03	4.31	4.71	4.13	4.33
	Girls.	3.87	4.18	4.28	4.18	4.69	4.87	4.51	5.55	5.29	4.58	4.41	4.05	4.28			
Girth of Chest*	Boys.	2.22	2.38	2.35	2.51	2.72	2.61	2.94	3.11	3.58	3.77	4.19	3.15	2.94			
	Girls.	2.48	2.47	2.40	2.53	2.67	3.04	3.24	3.54	3.65	3.70	3.27	3.34	3.23			
Total...	Boys.	13.72	14.47	14.64	14.94	15.05	16.84	17.16	20.42	22.90	25.90	27.59	21.48				
	Girls.	13.24	14.47	14.37	14.88	15.92	17.67	18.90	21.64	21.87	18.88	18.33	16.71	16.22			

* Obtained by adding Girth of Chest at full Inspiration to Girth of Chest at full Expiration and dividing by 2.

ured at each age is also stated, in order to secure a more
accurate general view.   It is seen that the total Absolute
Probable Deviation increases continuously from age 6 to age
16 in boys and from age 6 to age 15 in girls (except at age
8), after which periods there is a fall.   The increase is not
uniform, becoming suddenly much greater at age 13 in boys
and age 11 in girls, the accelerated increase extending over
four years in both sexes and ending as suddenly as it began.

It has been already said that the Absolute Probable Devia-
tion is entangled with the size of the individual.   In Table
No. 4 this obstacle has been removed and the Physiological
Difference of Individual from Type appears.   A comparison

TABLE No. 4.

The Relation of Probable Deviation (d) to Average (A). $\frac{d}{A}$.

Dimension.	Sex.	Age at Nearest Birthday and Relation of Probable Deviation to Average.															
		6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Weight	Boys.	7.2	7.8	8.2	8.0	7.9	8.4	7.3	10.6	11.3	11.0	12.0	7.9	6.9			
	Girls.	7.6	9.0	8.5	8.9	8.4	9.6	9.8	11.0	11.0	8.7	8.4	7.0	6.9	7.2	7.0	
Height Standing.	Boys.	3.1	3.2	3.3	3.0	3.1	3.2	3.2	3.5	3.8	4.1	3.7	3.1	2.8			2.7
	Girls.	3.2	3.3	3.1	3.1	3.1	3.2	3.4	3.8	3.7	3.4	2.6	2.2	2.1	2.6	2.0	
Height Sitting.	Boys.	4.6	4.2	3.5	3.5	3.5	3.6	3.8	3.7	4.1	4.5	4.2	4.4	3.3			2.2
	Girls.	3.4	3.5	3.2	3.2	3.2	3.4	3.6	3.8	4.0	3.1	2.8	2.6	2.0	2.1	2.4	
Span of Arms.	Boys.	3.5	3.6	3.5	3.4	3.6	3.6	3.2	3.9	4.0	4.5	4.8	3.0	2.5			
	Girls.	3.6	3.7	3.6	3.4	3.6	3.6	3.2	3.8	3.5	2.9	2.8	2.5	2.7	2.9	2.6	2.7
Girth of Chest*	Boys.	3.8	3.9	3.8	3.9	4.1	3.9	4.3	4.4	4.9	4.9	5.3	3.9	3.5			
	Girls.	4.3	4.2	3.9	4.0	4.2	4.6	4.7	5.0	4.9	4.7	4.1	4.2	4.0			
Total....	Boys.	22.2	22.7	22.3	21.8	22.2	22.2	21.8	26.1	28.1	29.0	30.0	22.3	19.0			
	Girls.	22.1	23.7	22.3	22.6	22.5	24.4	24.7	27.4	27.1	22.8	20.7	18.5	17.7			

* Obtained by adding Girth of Chest at full Inspiration to Girth of Chest at full Expiration and dividing by 2.

of this table with the preceding one is very instructive. The continuous increase observed in the Absolute Probable Deviation has disappeared Indeed the total Deviation at age 12 is less than at age 7. An important increase occurs in the years 13, 14, 15 and 16 in boys and 11, 12, 13 and 14 in girls. During these four years in each sex, the Physiological Difference of the Individual from the Type is greater than at any other time. Hence this difference does not increase with the age of the Type or with its size. The true relation of the Physiological Difference is made plain by a comparison of Relative Probable Deviation with Relative Annual Increase of Average

TABLE No. 5.

The Relative Annual Increase of Average.*

Dimension.	Sex.	Age at nearest Birthday and Relative Annual Increase of Average.											
		6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 13	13 to 14	14 to 15	15 to 16	16 to 17	17 to 18
Weight........	Boys.	9.7	9.7	9.6	8.7	9.5	8.1	9.3	10.5	14.3	11.6	7.9	5.3
	Girls.	10.0	9.9	9.6	9.6	9.7	11.6	14.3	9.9	10.4	7.6	4.7	
Height Standing..	Boys.	4.7	4.7	4.4	3.6	3.9	3.3	3.4	4.0	4.3	3.5	3.0	3.2
	Girls.	4.9	4.8	4.5	3.9	3.7	4.4	5.3	2.9	2.8	1.6	1.1	0.06
Height Sitting.....	Boys.	3.3	2.2	3.1	3.8	2.1	2.7	2.3	3.6	3.8	3.2	4.1	3.1
	Girls.	4.1	3.5	3.4	3.1	2.7	3.8	4.6	3.5	3.5	2.9	1.1	0.6
Span of Arms......	Boys.	5.0	4.9	4.3	4.0	3.8	4.3	3.2	4.3	4.7	3.5	2.8	4.0
	Girls.	5.0	5.3	4.5	4.1	4.3	4.3	5.1	3.7	2.5	1.4	3.2	0.9
Girth of Chest†...	Boys.	2.7	2.6	2.8	2.6	2.5	2.3	2.7	3.8	4.5	3.5	2.7	3.8
	Girls.	1.9	2.3	2.8	0.8	4.5	3.8	4.3	4.0	3.6	2.7	2.0	0.1
Total............	Boys.	25.4	24.1	24.2	22.7	21.8	20.5	20.9	26.2	31.6	25.3	20.5	19.4
	Girls.	25.9	25.8	24.8	21.5	24.9	27.9	33.6	24.0	22.8	16.2	12.1	1.7

* Obtained for age 6 to 7 by dividing the increase from age 6 to age 7 by the average at age 6; for age 7 to 8 by dividing the increase from age 7 to age 8 by the average at age 7; and so on.

† Obtained by adding Girth of chest at full inspiration to Girth of chest at full expiration and dividing by 2.

or quickness of growth, given in Table No. 5. The comparison is made easy by arranging the totals side by side. The

AGE.	Relative Probable Deviation.	Relative Increase of Average.	Relative Probable Deviation.	Relative Increase of Average.
	BOYS.	BOYS.	GIRLS.	GIRLS.
6...	22.2	....	22.1	....
7...	22.7	25.4	23.7	25.9
8...	22.3	24.1	22.3	25.8
9...	21.8	24.2	22.6	24.8
10...	22.2	22.7	22.5	21.5
11...	22.2	21.8	**24.4**	**24.9**
12...	21.8	20.5	**24.7**	**27.9**
13...	**26.1**	**20.9**	**27.4**	**33.6**
14...	**28.1**	**26.2**	**27.1**	**24.0**
15...	**29.0**	**31.6**	22.8	22.8
16...	**30.0**	**25.3**	20.7	16.2
17	22.3	20.5	18.5	12.1
18...	19.0	19.4	17.7	1.7

comparison reveals in both cases a general though not unbroken fall from age 7 to age 13 in boys and 11 in girls, a remarkable increase covering four years in both sexes, and a subsequent great decline. Thus the Relative Deviation coincides in the main with the Quickness of Growth. This relation is shown graphically in Plate I.

The phenomena just described are here seen to advantage. The curve of rate of growth in boys (unbroken red line) falls from age 7 to 12, corresponding to a small fall in Probable Deviation (unbroken black line). At age 12 to 13, a sudden change appears in both curves. They rise rapidly, reach a high maximum and suddenly fall to their former level. The period from the beginning of the rise to the return to the level of age 12 has the same duration in both curves. The maximum deviation is greater in Relative Annual Increase than in Relative Probable Deviation, a fact in accord with the greater stability of the latter, and the maximum Annual Increase occurs a little earlier than the maximum Probable Deviation. The period of acceleration is more sharply defined in Annual Increase. At age 18, both curves are still falling. The relation between the Rate of Growth
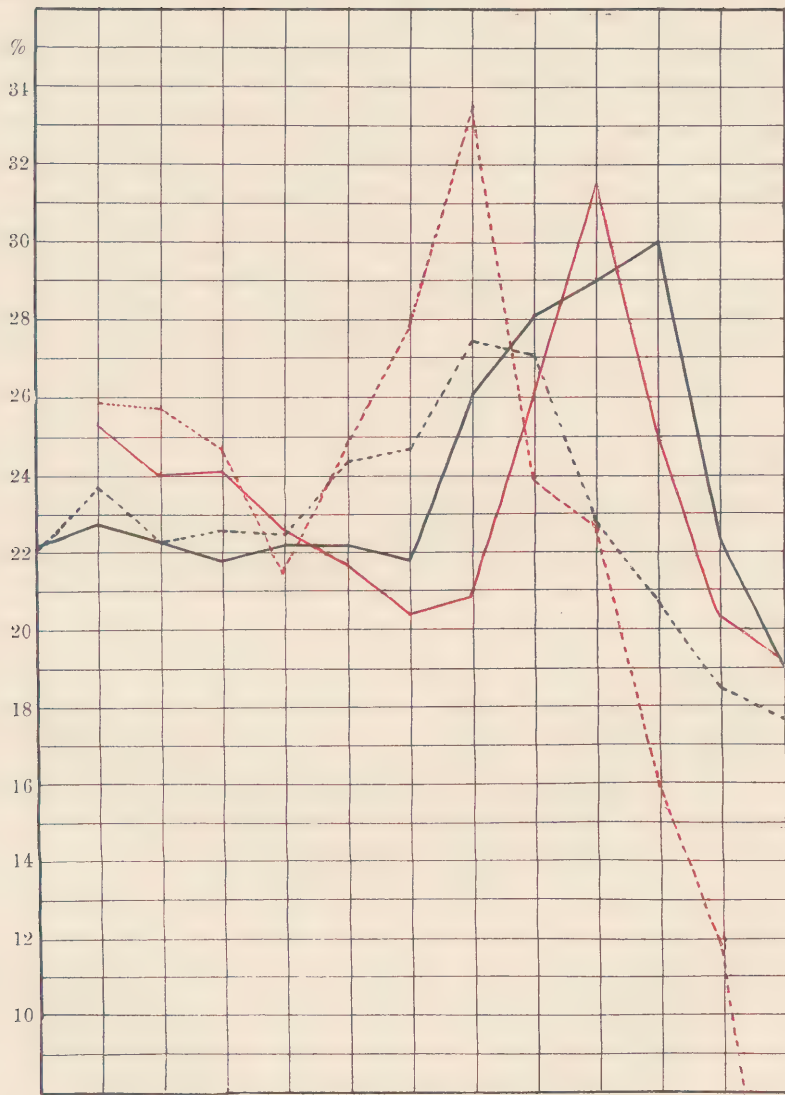
Black: Relative Probable Deviation.
Red: Relative Annual Increase of Average.

Unbroken Curves: Boys.
Broken Curves: Girls.

and Probable Deviation is even more clearly seen in the girls' curves (broken lines). The rapid rise begins in them at age 10 to 11, and reaches its maximum at the same age in both curves. The subsequent fall is profound.

The evidence presented above permits the conclusion : *The Physiological Difference between the individual children in an anthropometric series and the Physical Type of the series is directly related to the Quickness of Growth.*

TABLE No. 6.
DATA OF HEIGHT STANDING AND WEIGHT.

Age at Nearest Birthday	Sex	Height Standing (In Centimetres).						Weight (In Kilograms).					
		Number of Observations.	Average. *A*	Probable Error of Average. *E* ±	Probable Deviation. *d* ±	Relative Annual Increase of Average. %	Relation of Probable Deviation to Average. $\frac{d}{A}$ %	Number of Observations.	Average. *A*	Probable Error of Average. *E* ±	Probable Deviation. *d* ±	Relative Annual Increase of Average. %	Relation of Probable Deviation to Average. $\frac{d}{A}$ %
Six	Boys.	709	108.94	0.128	3.40		3.1	707	19.75	0.054	1.43		7.2
	Girls.	780	107.67	0.123	3.42		3.2	798	18.93	0.051	1.44		7.6
Seven	Boys.	1850	114.03	0.084	3.61	4.7	3.2	1814	21.67	0.039	1.68	9.7	7.8
	Girls.	1791	112.95	0.089	3.75	4.9	3.3	1714	20.82	0.045	1.88	10.0	9.0
Eight	Boys.	2223	119.13	0.082	3.89	4.7	3.3	2188	23.78	0.042	1.96	9.7	8.2
	Girls.	2193	118.36	0.079	3.70	4.8	3.1	2147	22.88	0.042	1.95	9.9	8.5
Nine	Boys.	2205	124.35	0.080	3.75	4.4	3.0	2188	26.66	0.045	2.09	9.6	8.0
	Girls.	2122	123.67	0.065	3.83	4.5	3.1	2055	25.08	0.049	2.23	9.6	8.9
Ten	Boys.	2087	128.87	0.087	3.98	3.6	3.1	2064	28.82	0.049	2.23	8.7	7.9
	Girls.	2053	128.43	0.089	4.06	3.9	3.1	1947	27.49	0.052	2.31	9.6	8.4
Eleven	Boys.	1819	132.84	0.099	4.23	3.9	3.2	1743	31.00	0.062	2.60	9.5	8.4
	Girls.	1772	133.19	0.106	4.48	3.7	3.2	1708	30.15	0.070	2.91	9.7	9.6
Twelve	Boys.	1653	138.21	0.116	4.47	3.3	3.2	1644	33.51	0.061	2.46	8.1	7.3
	Girls.	1732	139.11	0.098	5.23	4.4	3.4	1676	33.66	0.081	3.31	11.6	9.8
Thirteen	Boys.	1208	142.91	0.140	4.98	3.4	3.5	1242	36.61	0.110	3.88	9.3	10.6
	Girls.	1322	146.53	0.150	5.46	5.3	3.8	1343	38.49	0.115	4.22	14.3	11.0
Fourteen	Boys.	925	148.58	0.183	5.58	4.0	3.8	946	40.44	0.148	4.56	10.5	11.3
	Girls.	1085	150.84	0.156	5.15	2.9	3.7	1082	42.29	0.142	4.67	9.9	11.0
Fifteen	Boys.	490	154.90	0.286	6.33	4.3	4.1	498	46.22	0.227	5.06	14.3	11.0
	Girls.	680	155.04	0.154	4.01	2.8	3.4	690	46.69	0.154	4.05	10.4	8.7
Sixteen	Boys.	189	160.27	0.427	5.87	3.5	3.7	203	51.60	0.431	6.16	11.6	12.0
	Girls.	420	157.52	0.197	4.05	1.6	2.6	420	50.25	0.207	4.24	7.6	8.4
Seventeen	Boys.	78	165.13	0.592	5.15	3.0	3.1	71	55.67	0.521	4.38	7.9	7.9
	Girls.	206	159.33	0.241	3.45	1.1	2.2	230	52.61	0.244	3.70	4.7	7.0
Eighteen	Boys.	29	170.41	0.924	4.98	3.2	2.8	17	58.64	0.289	3.60	5.3	6.9
	Girls.	164	159.42	0.265	3.39	0.06	2.1	155	52.36	0.289	3.60		
Nineteen	Girls.	85	158.46	0.438	4.04		2.6	81	52.19	0.332	3.76		7.2
Twenty	Girls.	79	159.41	0.346	3.14		2.0	66	53.91	0.565	3.76		7.0
Twenty-one	Girls.	43	159.98	0.651	4.27		2.7						

TABLE No. 7.

DATA OF HEIGHT SITTING AND SPAN OF ARMS.

Age at Nearest Birthday.	Sex.	Height Sitting (In Centimetres).						Span of Arms (In Centimetres).					
		Number of Observations.	Average. A	Probable Error of Average. E ±	Probable Deviation. d ±	Relative Annual Increase of Average. %	Relation of Probable Deviation to Average. $\frac{d}{A}$ %	Number of Observations.	Average. A	Probable Error of Average. E ±	Probable Deviation. ± d	Relative Annual Increase of Average. %	Relation of Probable Deviation to Average. $\frac{d}{A}$ %
Six.........	Boys.	714	61.31	0.105	2.82		4.6	708	108.95	0.144	3.85		3.5
	Girls.	751	59.45	0.132	2.03		3.4	769	106.96	0.140	3.87		3.6
Seven.....	Boys.	1853	63.32	0.061	2.64	3.3	4.2	1862	114.42	0.096	4.16	5.0	3.6
	Girls.	1727	61.80	0.053	2.19	4.1	3.5	1724	112.36	0.107	4.18	5.0	3.7
Eight.....	Boys.	2239	64.74	0.043	2.26	2.2	3.5	2234	120.07	0.088	4.18	4.9	3.5
	Girls.	2120	63.97	0.044	2.04	3.5	3.2	2152	118.33	0.092	4.28	5.3	3.6
Nine........	Boys.	2258	66.73	0.049	2.34	3.1	3.5	2272	125.18	0.089	4.25	4.3	3.4
	Girls.	2071	66.16	0.046	2.11	3.4	3.2	2065	123.63	0.092	4.18	4.5	3.4
Ten........	Boys.	2118	69.25	0.040	2.42	3.8	3.5	2076	130.22	0.103	4.70	4.0	3.6
	Girls.	2037	68.19	0.049	2.19	3.1	3.2	2045	128.75	0.104	4.69	4.1	3.6
Eleven......	Boys.	1828	70.67	0.060	2.56	2.1	3.6	1810	135.13	0.113	4.84	3.8	3.6
	Girls.	1748	70.03	0.057	2.37	2.7	3.4	1757	134.24	0.116	4.87	4.3	3.6
Twelve.....	Boys.	1656	72.55	0.067	2.72	2.7	3.8	1664	140.60	0.112	4.57	4.1	3.2
	Girls.	1707	72.67	0.063	2.61	3.8	3.6	1718	140.07	0.109	4.51	4.3	3.2
Thirteen.....	Boys.	1285	74.20	0.076	2.74	2.3	3.7	1281	145.09	0.159	5.71	3.2	3.9
	Girls.	1354	76.03	0.078	2.87	4.6	3.8	1368	147.19	0.150	5.55	5.1	3.8
Fourteen......	Boys.	936	76.84	0.103	3.15	3.6	4.1	934	151.28	0.197	6.03	4.3	4.0
	Girls.	1065	78.68	0.095	3.11	3.5	4.0	1088	152.58	0.160	5.29	3.7	3.5
Fifteen......	Boys.	498	79.74	0.161	3.59	3.8	4.5	495	158.43	0.321	7.15	4.7	4.5
	Girls.	674	81.42	0.098	2.54	3.5	3.1	677	156.38	0.176	4.58	2.5	2.9
Sixteen......	Boys.	193	82.28	0.250	3.48	3.2	4.2	189	163.96	0.574	7.89	3.5	4.8
	Girls.	411	83.76	0.116	2.36	2.9	2.8	413	158.51	0.217	4.41	1.4	2.8
Seventeen.....	Boys.	77	85.68	0.427	3.77	4.1	4.4	75	168.56	0.581	5.03	2.8	3.0
	Girls.	202	84.66	0.153	2.17	1.1	2.6	202	159.01	0.285	4.05	3.2	2.5
Eighteen......	Boys.	31	88.23	0.536	2.89	3.1	3.3	32	175.31	0.761	4.31	4.0	2.5
	Girls.	167	85.20	0.133	1.72	0.6	2.0	164	160.47	0.334	4.28	0.9	2.7
Nineteen........	Girls.	85	84.86	0.198	1.82		2.1	83	158.45	0.517	4.71		2.9
Twenty..........	Girls.	78	85.31	0.230	2.03		2.4	76	160.17	0.474	4.13		2.6
Twenty-one........	Girls.	41	85.05	0.290	1.86		2.2	37	161.27	0.712	4.33		2.7

TABLE No. 8.
DATA OF GIRTH OF CHEST.

Girth of Chest* (In Centimetres).

Age at Nearest Birthday.	Sex.	Number of Observations.	Average. A	Probable Error of Average. $E\ \pm$	Probable Deviation. $d\ \pm$	Relative Annual Increase of Average. %	Relation of Probable Deviation to Average. $\dfrac{d}{A}$ %
Six........	Boys.	677	59.05	0.083	2.22		3.8
	Girls.	741	58.34	0.091	2.48		4.3
Seven........	Boys.	1708	60.62	0.057	2.38	2.7	3.9
	Girls.	1631	59.47	0.062	2.47	1.9	4.2
Eight........	Boys.	2095	62.18	0.052	2.35	2.6	3.8
	Girls.	2040	60.81	0.053	2.40	2.3	3.9
Nine........	Boys.	2120	63.90	0.055	2.51	2.8	3.9
	Girls.	1966	62.51	0.057	2.53	2.8	4.0
Ten........	Boys.	1997	65.59	0.061	2.72	2.6	4.1
	Girls.	1893	63.02	0.061	2.67	0.8	4.2
Eleven........	Boys.	1732	67.24	0.063	2.61	2.5	3.9
	Girls.	1654	65.85	0.075	3.04	4.5	4.6
Twelve........	Boys.	1565	68.76	0.074	2.94	2.3	4.3
	Girls.	1624	68.34	0.081	3.24	3.8	4.7
Thirteen........	Boys.	1228	70.61	0.089	3.11	2.7	4.4
	Girls.	1813	71.29	0.098	3.54	4.3	5.0
Fourteen........	Boys.	925	73.27	0.118	3.58	3.8	4.9
	Girls.	1020	74.13	0.114	3.65	4.0	4.9
Fifteen........	Boys.	498	76.56	0.169	3.77	4.5	4.9
	Girls.	659	76.78	0.143	3.70	3.6	4.7
Sixteen........	Boys.	205	79.22	0.293	4.19	3.5	5.3
	Girls.	397	78.85	0.164	3.27	2.7	4.1
Seventeen........	Boys.	80	81.39	0.353	3.15	2.7	3.9
	Girls.	206	80.39	0.233	3.34	2.0	4.2
Eighteen........	Boys.	31	84.52	0.528	2.94	3.8	3.5
	Girls.	162	80.45	0.254	3.23	0.1	4.0

* Obtained by adding Girth of Chest at full Inspiration to Girth of Chest at full Expiration and dividing by 2.